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A Coded Wire Tag Assessment of Salmon River (Langley) Coho Salmon: 1989 Tag Application and 1990-91 Spawner Enumeration

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August 1991

Canadian Manuscript Report of
Fisheries and Aquatic Sciences
No. 2114

Fisheries and Oceans Pêches et Océans

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Canadian Manuscript Report of

Fisheries and Aquatic Sciencee 2114

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by

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92-00725/

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Cat. No. Fs 97-4/2114E ISSN 0706-6473

Correct citation for this publication:

Farwell, M.K., N.D. Schubert and L.W. Kalnin. 1991. A coded wire tag assessment of Salmon River (Langley) coho salmon: 1989 tag application and 1990-91 spawner enumeration. Can. Manuscr. Rep. Fish. Aquat. Sci. 2114: 32 p.

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ABSTRACT

Farwell, M.K., N.D. Schubert and L.W. Kalnin. 1991. A coded wire tag assessment of Salmon River (Langley) coho salmon: 1989 tag application and 1990-91 spawner enumeration. Can. Manuscr. Rep. Fish. Aquat. Sci. 2114: 32 p.

In 1986, the Department of Fisheries and Oceans implemented a plan to improve the assessment data for coho salmon (*Oncorhynchus kisutch*) through the long term evaluation of key stocks. The Salmon River (Langley) was selected for the evaluation, with known precision, of annual escapement, marine survival, harvest distribution and exploitation rate. An estimated 26,911 (corrected for long term tag loss) coho smolts were released with coded wire tags (CWT) in spring of 1989 at an average size of 94.9 mm and 8.9 g. The adult escapement was estimated in fall and winter 1990-91 using the Petersen mark-recapture method. Escapement was estimated at 4,986 coho adults of which an estimated 791 had coded wire tags and 179 (18.4%) had lost the coded wire tag. Survival to escapement was 2.9%.

Key Words: Coho salmon, Salmon River (Langley), key stream, coded wire tag, escapement, survival.

RÉSUMÉ

Farwell, M.K., N.D. Schubert and L.W. Kalnin. 1991. A coded wire tag assessment of Salmon River (Langley) coho salmon: 1989 tag application and 1990-91 spawner enumeration. Can. Manuscr. Rep. Fish. Aquat. Sci. 2114: 32 p.

En 1986, le ministère des Pêches et Océans a entrepris une évaluation à long terme des stocks clés pour améliorer la base de données sur le saumon coho (*Oncorhynchus kisutch*). Il a choisi de faire cette évaluation dans la rivière Salmon (Langley) et d'établir des données précises sur l'échappée annuelle, la survie, la répartition des captures et le taux d'exploitation. Au printemps de 1989, environ 26 911 (chiffre ajusté pour tenir compte des pertes à long terme de micromarques magnétisées codées) jeunes saumons mesurant en moyenne 94,9 mm, pesant en moyenne 8,9 g, et pourvus d'une micromarque magnétisée codée ont été relâchés. L'échappée des adultes a été estimée à l'automne et au printemps de 1990-91 au moyen de la technique Petersen de marquage-recapture. L'échappée a été estimée à 4 986 poissons, dont 791 avaient encore leur micromarque et 179 (18,4%) l'avaient perdue. La survie à l'échappée des cohos géniteurs de 1987 de la rivière Salmon était de 2,9%.

Mots clés: Saumon coho, rivière Salmon (Langley), cours d'eau important, micromarque magnétisée codée, échappée, survie.

INTRODUCTION

In 1986, the Department of Fisheries and Oceans implemented a plan to improve coho salmon assessment data through the long term evaluation of key stocks. The Salmon River was selected for the evaluation, with known precision, of annual escapement, marine survival, harvest distribution and exploitation rate.

The Salmon River was designated a key stream for three reasons. First, recent escapements of Salmon River coho comprised 4% of the Fraser River total (Farwell et al. 1987). The status of this stock, therefore, is an important measure of the status of the Fraser River coho resource. Second, data collected from the 1976-78 brood years (Schubert 1982a; Schubert and Fleming 1989) provided a time series of comparable data. Third, simplified logistics limited project costs.

This report documents, for the 1987 brood, the 1989 coho smolt coded wire tag (CWT) application and 1990-91 coho adult escapement estimation studies. Previous reports documented the evaluation of the 1984-86 brood years (Schubert and Kalnin 1990; Farwell et al. 1991; Kalnin and Schubert 1991). This report describes field methodologies, analytic techniques and study results, including smolt timing, age and size and adult age, length, sex, adipose fin clip (AFC) incidence and estimates of escapement and long term CWT loss. The study did not estimate the escapement of precocious males (jacks). The report concludes with a discussion of data limitations.

STUDY AREA

The Salmon River flows northwest for 33 km, entering the Fraser River west of Fort Langley (Fig. 1). Coghlan Creek, the principal tributary, joins the mainstem 14 km upstream from the Fraser River. The system, with an average annual discharge of 1.41 m^3/s (Environment Canada 1986), drains 85 km^2 of agricultural and residential land. During the Fraser River spring freshet, the Salmon River passes through a pumphouse located at the river mouth. No provisions were made for fish passage. Up to 31% of the coho smolts are killed when they pass through the pumps (Russell MS 1981).

Coho adults enter the river at ages 3_2 and 4_3 and spawn in the middle and upper reaches from November to January (Schubert 1982b; Schubert and Fleming 1989). Coho escapements averaged 3,000 and 2,400 in 1970-79 and 1980-86, respectively (Farwell et al. 1987).

METHODS

JUVENILE PROGRAM

Fish Capture

Fence traps similar to those described by Schubert (1982a) operated in the Salmon River (30 m above the Coghlan Creek confluence) from April 21 to May 27, 1989 and in Coghlan Creek (50 m above the Salmon River confluence) from April 19 to May 27, 1989.

Captured fish were enumerated at least once daily. Coho smolts were transferred to holding boxes or to the tagging site for tagging and sampling. Coho fry were not enumerated because the 6 mm fence mesh did not fully restrict their passage. The remaining catch was identified to species and released below the fence. Steelhead and cutthroat trout were recorded as smolt or presmolt. Smolts had a silver coloration and a nose-fork (NF) length greater than 11 cm. Presmolts had distinct parr marks and a NF length less than 11 cm.

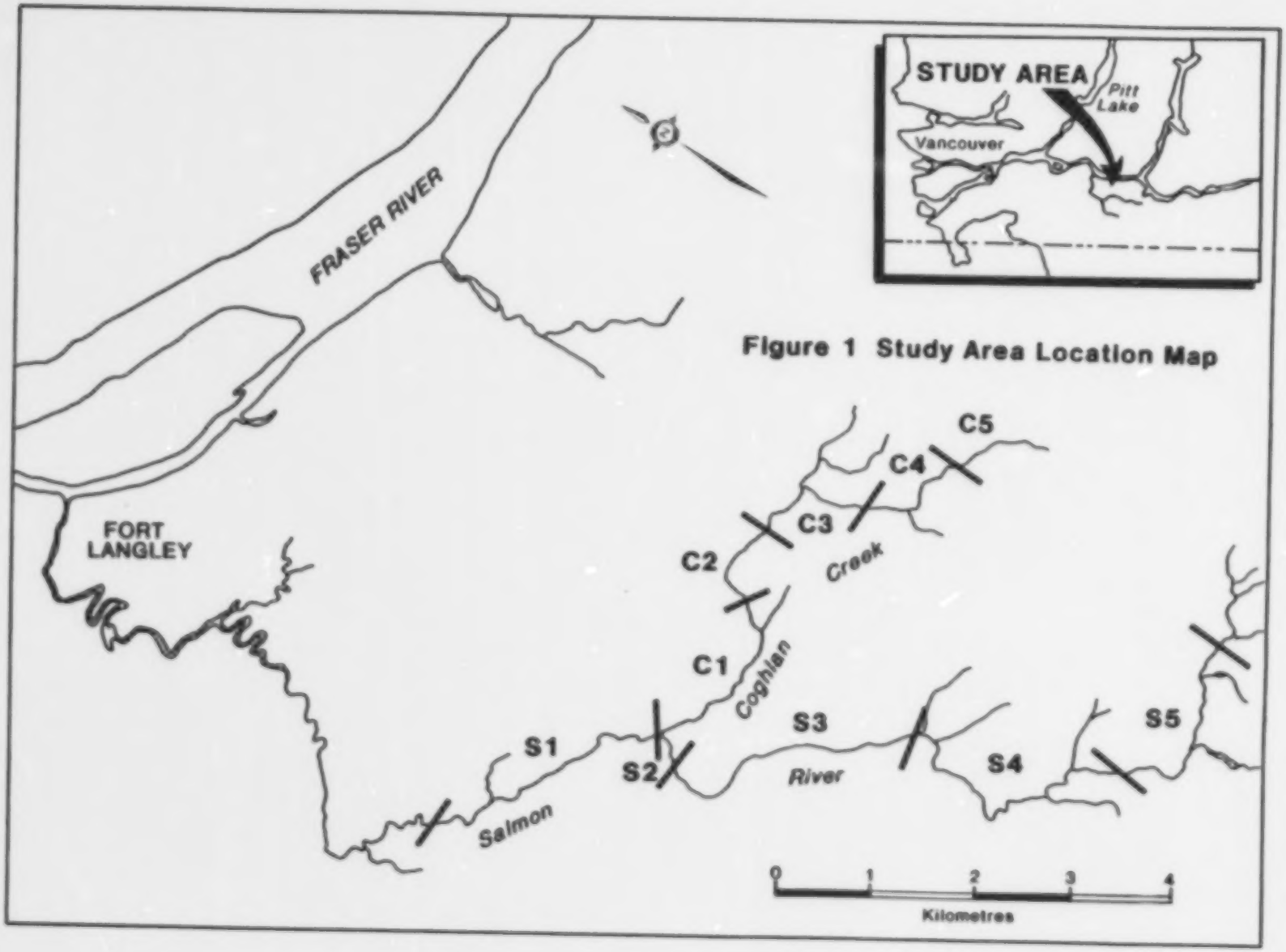

Figure 1 Study Area Location Map

Coded Wire Tagging

The CWT equipment and methods were described by Armstrong and Argue (1977). Coded wire tagging occurred from April 21 to May 15, 1989 at intervals of one to three days. On each day, smolts were sorted by size (NF length greater or less than 100 mm) and separate nose moulds and implant depths were used for each group. Implant depth was checked for each group by bisecting the skull of a tagged smolt along the median plane. If the CWT was not in the preferred position in the cartilaginous wedge of the skull, the implant depth was adjusted and the procedure repeated until CWT placement was correct. The nose mould was then marked to permit correct placement after nose mould changes.

The smolts were anaesthetized with Tricaine Methane Sulfonate (TMS), marked by adipose fin removal, coded wire tagged and passed through a quality control device to ensure the CWT was present. Any diseased, damaged or undersize (NF length less than 55 mm) smolts were released untagged. A representative sample of approximately 250 smolts was removed from the recovery bucket and retained for 24 hours for assessment of AFC quality, delayed mortality and CWT loss. Any coho without a CWT or with a poor AFC was retagged or reclipped. All smolts were then transported and released, or held until morning when water temperatures were more suitable for transport.

Transport

Coded wire tagged smolts were released at the Salmon River mouth to avoid pump related mortality. The smolts were transported in five gallon plastic buckets supplied with air from a twelve volt air pump. Transport required less than fifteen minutes.

Sampling

Fifty coho smolts per site were sampled twice weekly for scales, length and weight. The smolts were anaesthetized with TMS, a scale smear was removed with a scalpel from each preferred region, NF length was measured to the nearest millimetre, and mean wet weight (±0.1g) was determined in aggregate on an Ohaus triple beam balance.

ADULT PROGRAM

Fish Capture

Coho adults were captured in reaches S1 to S5 and C1 to C5 (Fig. 1) from October 31 to November 30, 1990. Coho were attracted from log jams and cut banks with an electroshocker using direct current. Voltage (600 volts) and frequency (15 to 30 milliseconds) were adjusted daily to ensure the fish were undamaged, but stunned sufficiently to permit capture. Stunned coho were captured in a dip net, permitted to recover in a 60 l container of water, disk tagged and released.

Disk Tag Application

Coho adults (NF length greater than 30 cm) were Petersen disk tagged in a wooden tray (10 cm x 10 cm x 100 cm) constructed with a flexible plastic bottom and a meter stick recessed in one side. The tags consisted of two 2.2 cm diameter laminated cellulose acetate disks and one 0.7 cm diameter transparent plastic buffer disk threaded through centrally punched holes onto a 7.7 cm long nickel pin. The pin was inserted with pliers through the musculature and pterygiophore bones approximately 1.2 cm below the anterior portion of the dorsal fin insertion. The disk tags, arranged with one on each side

of the fish and with a buffer disk on the pin head side, were secured by twisting the pin into a double knot. One disk per pair was numbered with a unique code. Green disk tags were used to reduce colour contrast, thereby minimizing recovery and predation biases.

Each disk tagged fish received a secondary mark to allow the assessment of disk tag loss. One or two 0.7 cm diameter holes were punched through the right operculum of males and females, respectively, using a single hole paper punch. Care was taken to avoid gill tissue damage.

Date and location (reach) of capture, disk tag number, MF length (to the nearest 0.1 cm), sex and adipose fin status were recorded for each fish released with a disk tag. Release condition was recorded as 1 (swam away vigorously), 2 (swam away sluggishly) or 3 (required ventilation). Recovered disk tagged carcasses were enumerated and sampled (described below) to assess handling mortality.

Stream Surveys

Weekly stream surveys were conducted from November 20, 1990 to January 3, 1991. Complete surveys, conducted by a two to four person crew walking in an upstream direction, required up to two days.

Live adults were counted and carcasses were recorded by date, reach, sex (confirmed by abdominal incision) and mark type (disk tag, secondary mark or AFC). Each marked carcass and every tenth unmarked carcass was sampled. Carcasses less than 30 cm MF length were recorded as jacks. All carcasses were then cut in two with a machete and returned to the river. Sample data, recorded by date and reach, included post-orbital-hypural plate (POH) length (to the nearest 0.1 cm), sex, female spawning success (0%, 50% or 100% spawned), adipose fin and carcass condition, and scale samples. The head of AFC coho was removed posterior to the eye orbit for later CWT identification. Adipose fin condition was recorded as unclipped, complete (flush with dorsal surface), partial (nub present) or questionable (appeared clipped but fungus or decomposition obscured area). The condition of AFC carcasses was recorded as fresh (gills red or mottled), moderately fresh (gills white, body firm), moderately rotten (body intact, flesh soft) or rotten (skin and bones), and the absence of one or both eyes was noted.

Escapement Estimation

Total Escapement: The 1990-91 escapement of Salmon River coho adults was calculated from the mark-recapture data using the Petersen formula (Chapman modification) (Ricker 1975). Total escapement was the sum of escapement by sex:

1) Estimated Salmon River system coho escapement (N_t):

$$N_t = N_m + N_f$$

where:

N_m = estimated escapement of adult males;

$$= \frac{(M_m + 1)(C_m + 1)}{(R_m + 1)}$$

N_f = estimated escapement of females, analogous to above.

2) Estimated 95% confidence limits of N_t:

$$N_t \pm 1.96\sqrt{V_t}$$

where:

N_t = total escapement estimate;
V_t = variance of the escapement estimate;
= $V_m + V_f$
V_m = variance of the adult male escapement estimate;

$$= \frac{(N_m^2)(C_m - R_m)}{(C_m + 1)(R_m + 2)}$$

N_m = adult male escapement estimate;
C_m = number of adult male carcasses examined for disk tags;
R_m = number of disk tagged or secondary marked adult males recovered;
V_f = variance of female escapement estimate, analogous to above.

Sex Identification Correction: The disk tag application data were corrected for sex identification error. Error occurred because the development of sexually dimorphic traits was often not advanced and internal examinations could not be made. Correction of recovery data was unnecessary because all carcasses were incised and examined internally. Sex identification error was corrected as described by Staley (1990):

3) Estimated true number of males released with disk tags and secondary marks (M_m):

$$M_m = \frac{M'_m - (M_t R_{m,f})/R_f}{1 - (R_{m,f}/R_f) - (R_{f,m}/R_m)}$$

where:

M'_m = field estimate of number of males released with disk tags and secondary marks;
M_t = total number of coho adults released with disk tags and secondary marks;
$R_{m,f}$ = number of females recovered with disk tags which were released as males;
$R_{f,m}$ = number of males recovered with disk tags which were released as females;
R_f = number of females recovered with disk tags;
R_m = number of males recovered with disk tags.

4) Estimated true number of females released with disk tags and secondary marks (M_f):

$$M_f = M_t - M_m$$

Adipose Fin Clipped Escapement: The estimated AFC escapement was the product of the AFC incidence in the carcass recovery sample, the largest of the two available samples, and the mark-recapture escapement estimate. Ninety-five percent confidence limits were calculated from the respective upper and lower confidence limits of the AFC incidence and the escapement estimate. For example, the upper 95% confidence limit of the AFC escapement estimate was the product of the upper limit of the AFC incidence and the upper limit of the total mark-recapture estimate. The mathematical relationships are reported below (Cochran 1977):

5) Estimated AFC escapement (N_a):

$$N_a = p(N_t)$$

6) Estimated 95% confidence limits for p:

$$p \pm 1.96 \text{ (se + fpc)}$$

where:

p = proportion of the sample with an AFC;

se = standard error;

$$= \sqrt{(1-f)pq/(n-1)}$$

fpc = finite population correction;

$$= \frac{1}{2n}$$

n = sample size;

q = 1-p

$$f = \frac{n}{N_t}$$

Coded Wire Tagged Escapement: Escapement by CWT code and long term CWT loss were calculated by applying the CWT composition in the carcass recovery sample to the estimated escapement of AFC adults. Apparent CWT loss was adjusted for post-mortality loss resulting from carcass decomposition and predator activity, when appropriate.

RESULTS

JUVENILE PROGRAM

Fish Capture

Catch of coho smolts totalled 39,217 in 1989, 25,649 in Salmon River and 13,568 in Coghlan Creek (Appendix 1). The 50% migration and the peak daily catch occurred on May 5 and May 2, respectively, in the Salmon River, and on May 3 and April 27, respectively, in Coghlan Creek. The traps operated throughout the main smolt migration period; therefore, catch records should approximate the true timing of the 1989 smolt migration.

Coded Wire Tagging

AFC and CWT releases totalled 33,092 coho smolts in 1989 (Appendix 2). When adjusted for long term CWT loss (18.4%)(Appendix 9) and short term (24-hour) post tagging mortality (111), the number released with CWTs and identifiable AFCs was 26,911.

Short term CWT loss averaged 5.5% (range 0.1% to 29.3%). The incidence of poor AFCs averaged less than 0.1%. The incidence of disease, damage, or structural anomalies averaged 18.1% (5,992)(Appendix 3). The most prevalent condition was "fog eye" (11.5%), a reversible condition associated with capture stress. Three smolts with naturally missing adipose fins were observed.

Coho Smolt Age and Size

Coho emigrated from the Salmon River system as yearling (age 1+) (99.6%) and two year old (age 2+) (0.4%) smolts. Smolt size averaged 95.2 mm in the Salmon River and 94.4 mm in Coghlan Creek and 8.9 g in both areas (Appendix 4). Weighted mean smolt size was 94.9 mm and 8.9 g. Salmon River smolt size decreased to a minimum in mid May and increased through the remainder of the migration. Coghlan Creek smolt size showed a similar trend with the minimum occurring in early May.

ADULT PROGRAM

Mark-Recapture

Disk Tag Application: Four hundred and thirty coho adults were released with disk tags and secondary marks from October 31 to November 30, 1990 (Table 1)(Appendix 5). Of that total, 120 had AFCs. Condition at release was good, except 51 (11.9%) required ventilation (Table 2). No difference ($p > 0.05$; chi-square) was noted in the proportion of this group recovered on the spawning grounds.

Table 1. Disk tag application, carcass examination and mark recovery, by sex, of Salmon River system coho adults, 1990-91.

	Disk tags applied	Carcasses examined[b]	Marked carcasses recovered[b]: Disk tag and secondary mark	Secondary mark only	Disk tag only	Total	Percent recovered
Male	215[a]	387	41	0	1	42	19.5%
Female	215[a]	477	31	1	1	33	15.4%
Adipose present	310	696	49	0	2	51	16.5%
Adipose absent	120	168	23	1	0	24	20.0%
Total	430	864	72	1	2	75	17.4%

[a] Adjusted for sex identification errors.
[b] Jacks excluded.

Table 2. Disk tag application and recovery of Salmon River system coho adults, by release condition, 1990-91.

Release condition	Disk tags applied	Disk tags recovered	Percent recovered
Fish swam away without assistance	379	64	16.9%
Fish required ventilation	51	10	19.6%
Total	430	75[a]	17.4%

[a] Includes 1 with a secondary mark only.

An estimated 2.4% of the males and 6.3% of the females were misidentified at the time of tagging (Appendix 6). When adjusted for sex identification error, an estimated 215 (50.0%) males and 215 (50.0%) females were released with disk tags and secondary marks.

Spawning Ground Recovery: Eight hundred and sixty-four adults and 16 jacks were recovered on the spawning grounds from November 20, 1990 to January 3, 1991 (Table 1; Appendix 7). Of the adults, 387 (44.8%) were male and 477 (55.2%) were female, 75 (8.7%) had disk tags or secondary marks and 168 (19.4%) had an AFC. Of those with disk tags or secondary marks, 2 (2.7%) had no secondary mark and 1 (1.3%) had lost the disk tag. At these levels, the incidence of fish which may have lost both marks would not have influenced study results. One of the jacks had an AFC. Twenty-three of the AFC adults were disk tagged. The proportion of the disk tagged AFC coho which was recovered (20.0%) was not significantly different ($p > 0.05$; chi square) than that of disk tagged coho with no AFC (16.5%).

Sampling Selectivity

Period: Temporal bias in the application sample was examined by comparing between periods the mark incidence in the recovery sample (Table 3). No significant difference ($p > 0.05$; chi square) was noted in females or males.

Recovery bias was examined by stratifying the application sample by period and comparing the proportions recovered (Table 4). A significant difference ($p < 0.05$) was noted, with coho tagged later in the study recovered at higher rates.

Location: Spatial bias in the application sample was examined by comparing between sections the mark incidence in the recovery sample (Table 5). Mark incidence, which ranged from 3.5% to 11.8%, was significantly different from that expected ($p < 0.05$; G-test). Mark incidence was lowest in the upper Salmon River.

Recovery bias was examined by stratifying the application sample by section and comparing the proportions recovered (Table 6). A significant difference ($p < 0.05$) was noted, with the lowest recovery from coho tagged in the lower Salmon River.

Fish Size: Size related bias in the application sample was examined by comparing the continuous POH length-frequency distributions of marked and unmarked spawning ground recoveries. No significant difference was noted in males or females ($p > 0.05$; Kolmogorov-Smirnov two sample test).

Recovery bias was examined by partitioning the application sample into recovered and non-recovered components and comparing the continuous NF length frequency distributions of each. Although the proportion recovered increased with NF length (Table 7), the difference was not significant ($p > 0.05$).

Fish Sex: Sex related bias in the application sample was examined by comparing the sex ratio of the marked and unmarked spawning ground recoveries (Table 8). A significant difference was noted ($p > 0.05$; chi-square) with the sample biased toward males.

Recovery bias was examined by partitioning the application sample into recovered and non-recovered components and comparing the sex ratio

Table 3. Incidence of disk tags or secondary marks in coho adults recovered on the Salmon River system spawning grounds, by period and sex, 1990-91.

Recovery period	Recovered with disk tag or secondary mark			Total recoveries[a]			Percent with disk tag or secondary mark		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
20-Nov to 28-Nov	21	8	29	161	171	332	13.0%	4.7%	8.7%
07-Dec to 14-Dec	20	22	42	194	249	443	10.3%	8.8%	9.5%
21-Dec to 04-Jan	1	3	4	32	57	89	3.1%	5.3%	4.5%
Total	42	33	75	387	477	864	10.9%	6.9%	8.7%

[a] Excludes jacks.

Table 4. Proportion of the disk tag application sample recovered on the Salmon River system spawning grounds, by application period, 1990-91.

Application period	Disk tags applied	Marked carcasses recovered	Percent recovered
31-Oct to 10-Nov	156	13	8.3%
11-Nov to 18-Nov	115	25	21.7%
19-Nov to 30-Nov	159	36	22.6%
Total	430	75[a]	17.4%

[a] Includes 1 with a secondary mark only.

Table 5. Incidence of disk tags and secondary marks, by section, in the Salmon River system spawning ground recovery sample, 1990-91.

Location	Section[a]	Carcasses examined		Carcasses recovered with disk tags or secondary marks	
		Number[b]	Percent of total	Number	Mark Incidence
Salmon River	Lower	131	15.2%	8	6.1%
	Middle	110	12.7%	12	10.9%
	Upper	174	20.1%	6	3.5%
Coghlan Creek	Lower	170	19.7%	16	9.4%
	Upper	279	32.3%	33	11.8%
Total	-	864	100.0%	75	8.7%

[a] Salmon River: lower - S1 and S2; middle - S3; upper - S4 and S5; Coghlan Creek: lower - C1; upper - C2, C3, C4 and C5.
[b] Excludes jacks.

Table 6. Proportion of the disk tag application sample recovered on the Salmon River system spawning grounds, by application section, 1990-91.

Location	Section[a]	Disk tags applied		Disk tags recovered	
		Number	Percent of total	Number	Percent recovered
Salmon River	Lower	144	33.5%	8	5.6%
	Middle	42	9.8%	8	19.1%
	Upper	78	18.1%	11	14.1%
Coghlan Creek	Lower	63	14.7%	13	20.6%
	Upper	103	24.0%	34	33.0%
Total	-	430	100.0%	75[b]	17.4%

[a] See Table 5 for section descriptions.
[b] Includes 1 with a secondary mark only.

Table 7. Disk tag application and recovery of Salmon River system coho adults, by nose-fork length, 1990-91.

Nose-fork length (cm)	Disk tags applied	Carcasses recovered with disk tags	Percent recovered
30-39	3	0	0.0%
40-49	64	8	12.5%
50-59	271	43	15.9%
60-69	88	22	25.0%
70-79	3	1	33.0%
Total	430[a]	75[b]	17.4%

[a] Includes 1 coho adult not measured at release.
[b] Includes 1 with a secondary mark only.

Table 8. Sex composition of Salmon River system coho adults in the disk tag application and spawning ground recovery samples, 1990-91.

		Application sample[a]			Spawning ground recovery sample[b]		
Sex		Recovered	Not Recovered	Total	Disk tag or secondary mark	Unmarked	Total
Male	N	42	173	215	42	345	387
	%	56.0	48.7	50.0	56.0	43.7	44.8
Female	N	33	182	215	33	444	477
	%	44.0	51.3	50.0	44.0	56.3	55.2
Total		75	355	430	75	789	864

[a] Corrected for sex identification error.
[b] Excludes jacks.

in each (Table 8). No significant difference was noted ($p > 0.05$). Furthermore, no significant difference was noted in the proportion of males (19.5%) and females (15.4%) released with disk tags and recovered on the spawning grounds (Table 1).

Spawning Success: Spawning success, estimated from the internal examination of female spawning ground recoveries, was estimated at 97.9% (Appendix 8). Spawning success of marked (96.8%) and unmarked (98.3%) females was not significantly different ($p > 0.05$; difference in proportions test).

Estimation of Spawner Population

Total Escapement: The 1990-91 escapement of Salmon River coho adults, calculated from mark-recapture data, was 4,986 (Table 9). Upper and lower 95% confidence limits were 6,097 and 3,874, respectively. The escapement of female and male coho adults was 3,037 and 1,949, respectively.

Adipose Fin Clipped Adults: Based on the coho adult AFC incidence in the spawning ground sample (19.4%; Table 1), the 1990-91 escapement of AFC adults was 970, with upper and lower 95% confidence limits of 1,095 and 844, respectively (Table 9). Of that total, an estimated 333 returned with CWT code 02 57 25, 458 with CWT code 02 63 22, and 179 (18.4%) had lost the CWT (Appendix 9). CWT loss was not influenced by carcass condition or predators ($p > 0.05$; chi-square) (Appendix 10). Survival from smolt release to adult escapement was 2.9%; however, the survival was significantly higher ($p < 0.05$, chi-square) in late (code 02 63 22) (3.5%) versus early (code 02 57 25) (2.3%) releases. There were no differences between CWT code distributions by recovery reach or period ($p > 0.05$, chi- square).

Age, Length and Sex

The age and length of 115 coho salmon recovered on the spawning grounds is summarized by sex in Appendix 11. The females were 98.4% age 3_2 and 1.6% age 4_3. The males were 3.6% age 2_2, 94.6% age 3_2 and 1.8% age 4_3. Mean NF length of male adults and females in the application sample was 54.1 cm and 56.9 cm, respectively (Appendix 11). No significant difference ($p > 0.05$; single class ANOVA) was noted between those with and without an AFC. Females were significantly longer than males ($p < 0.05$; single class ANOVA). Mean POH length of male adults and females in the recovery sample was 44.2 cm and 46.8 cm, respectively (Appendix 11). No significant difference ($p > 0.05$; single class ANOVA) was noted between those with and without an AFC. Females were significantly longer than males ($p < 0.05$; single class ANOVA).

Females comprised 50.0% of the application sample, 55.2% of the recovery sample (Table 8) and 60.9% of the Petersen population estimate.

DISCUSSION

GENERAL

Juvenile Program

The 1989 release of 26,911 coded wire tagged coho smolts was larger than in any previous study year (Table 11). Similarly, the AFC incidence in the escapement was higher than in previous years, suggesting that the higher catch reflected a higher sampling rate rather than elevated smolt production.

Long term CWT loss averaged 14.9% over the four year study, within the range reported elsewhere (e.g. Schubert and Fleming 1989). Brood

Table 9. Escapement estimates, by sex and AFC status, for Salmon River system coho adults, 1990-91.

	Escapement estimate	95% confidence limit	
		Lower	Upper
Male	1,949	1,406	2,492
Female	3,037	2,067	4,006
Total	4,986	3,874	6,097
AFC Adult	970	844	1,095

Table 10. Smolt release, adult escapement, and survival to adult escapement of coded wire tagged 1987 brood Salmon River system coho salmon.

CWT Code	Brood year	Number released[b]	Spawning ground recoveries[a]		Estimated AFC escapement	Percent survival to escapement
			Number	%		
02 57 25	1987	14,185	56	34.4%	333	2.3%
02 63 22	1987	12,726	77	47.2%	458	3.5%
No pin	-	-	30	18.4%	179	-

[a] Excludes 5 recovered without heads.
[b] Adjusted for long term CWT loss.

Table 11. Smolt release, escapement, survival and long term CWT loss in 1984-87 brood Salmon River coho salmon.

Dominant brood year	Dominant escapement year	Number of smolts released with CWT's	Escapement		CWT escapement	Survival to escapement (%)	Long term CWT loss	Percent of escapement with AFCs
			Female	Total				
1984	1987-88	7,891	5,197	11,947	373	4.7%	21.6%	3.4%
1985	1988-89	20,022	5,779	9,152	1,082	5.4%	13.5%	14.4%
1986	1989-90	24,634	4,458	8,427	864	3.5%	6.2%	10.9%
1987	1990-91	26,911	3,037	4,986	791	2.9%	18.4%	19.4%

year CWT loss varied considerable and was not related to short term loss. The chief utility of the latter is as an immediate operational feedback on tagger performance rather than as a predicter of long term CWT loss.

The 1989 juvenile program reported the first smolts with a naturally missing adipose fin since this study began. The incidence (< 0.01%) was too low to influence estimates of the AFC escapement or long term CWT loss.

Adult Program

The apparant efficiency of 1990-91 field activities improved over 1989-90 and 1988-89 (Table 12). This was especially notable in the proportion of the escapement which was disk tagged, which increased by 25% over 1989-90. Improvement probably reflected the pattern of freshets, which tended to precede the major immigration in 1990.

ADULT CAPTURE TECHNIQUE

A basic assumption underlying Petersen mark-recapture studies is that capture and tagging must not influence the subsequent catchability of the fish. Previous studies in the Salmon River identified a significant difference in the spawning success of marked versus unmarked females which may have been related to electroshocking stress (Schubert and Kalnin 1990; Kalnin and Schubert 1991; Farwell et al. 1991). The present study showed no difference in the spawning success of marked and unmarked females. This suggests that, at least in 1990-91, the use of electricity for fish capture was unlikely to have biased study results.

SAMPLING SELECTIVITY

A second assumption underlying Petersen mark-recapture studies is that the population is sampled in a random or representative manner (Ricker 1975). In studies when nonrepresentative sampling occurs, accurate results may still be achieved if one sample is representative (Robson 1969). As in previous years, it was not possible to test for representativeness because the true population parameters were not known. Instead, we examined the samples for four biases, temporal, spatial, fish size and fish sex, as indicators of weaknesses in the study design. Biases were identified in both the tag application and recovery samples (Table 13). The application sample had a spatial and fish sex bias, while the recovery sample had a temporal and spatial bias.

The spatial bias in both the application and recovery samples could potentially bias study results; however, because the direction of the biases were dissimilar, estimation error was probably minor. To investigate this assumption, we stratified the data by section and estimated the escapement using Schaefer's modification of the Petersen method for use with stratified populations (Ricker 1975). This estimate (5,206) was 3.5% higher than the Petersen estimate but well below it's upper 95% confidence limit. We concluded, therefore, that the assumption was valid; however, because similar spatial biases were reported for the 1989-90 escapement (Farwell et al. 1991), spatial patterns should be assessed before undertaking future studies.

ESCAPEMENT AND SURVIVAL

The 1990-91 escapement of 4,986 was the the third consecutive year of escapement declines in the Salmon River (Table 11). Escapement declined by 41% from 1989-90 and by 58% from 1987-88 (Table 11). Female escapement declined by 32% and 42% over the same periods. Similar but

Table 12. Adult study efficiency as indicated by the proportion of the Salmon River adult escapement which was disk tagged, censused and recovered, 1987-88 to 1990-91.

		Application Sample		Census sample		Marks recovered	
Year	Escape-ment	Total	Percent of total escape-ment	Total	Percent of total escapement	Total	Percent recovered
1987-88	11,947	1,322	11.1%	3,302	27.6%	352	26.6%
1988-89	9,152	717	7.8%	1,377	15.0%	107	14.9%
1989-90	8,427	495	5.9%	1,327	15.7%	80	16.2%
1990-91	4,986	430	8.6%	864	17.3%	75	17.4%
Mean	8,628	741	8.3%	1,718	18.9%	154	18.8%

Table 13. Results of statistical tests for bias in the 1990-91 Salmon River escapement estimation study.

Test	Application Sample	Recovery Sample
Period	No bias	Bias towards later period
Location	Bias in upper Salmon River	Bias in lower Salmon River
Fish size	No bias	No bias
Fish sex	Bias to males	No bias

less severe declines were also noted in the survival from smolt to escapement, i.e. excluding harvest. The survival of 1990-91 adults averaged 2.9%, a decline of 17% from 1989-90 and 38% from 1987-88 (Table 11). The reason for this decline will not be known until estimates of CWT harvest are finalized.

SUMMARY

1. The Salmon River (Langley) coho stock is one of a group of British Columbia stocks being monitored to evaluate responses to management actions by measuring, with known precision, annual escapement, marine survival, harvest distribution, and exploitation rate.

2. Coded wire tags (CWTs) and adipose fin clips (AFCs) were applied to emigrant smolts from April 21 to May 15, 1989. Smolts were captured at fence traps in the Salmon River and Coghlan Creek, the principal tributary. Tagged smolts were transported and released downstream of a pumphouse at the river mouth.

3. A total of 26,911 coho smolts were release with CWTs and AFCs. Size averaged 94.9 mm NF length and 8.9 g wet weight.

4. Adult spawners were enumerated by a mark-recapture study from October 31, 1990 to January 3, 1991. Coho adults were captured using an electroshocker and marked with Petersen disk tags and opercular punches. The escapement was censused by the recovery of carcasses following spawning.

5. The 1990-91 coho adult escapement was estimated from a disk tag application sample of 430, a recovery sample of 864, and a recovery of 75 carcasses with disk tags or secondary marks. The estimated escapement was 4,986 coho adults, of which 3,037 were female, 1,949 were male, and 970 had adipose fin clips.

6. The estimated return to the spawning grounds of CWT codes 02 57 25 and 02 63 22 were 333 and 458, respectively. Survival from smolt release to spawning ground recovery for these two CWT codes was 2.3% and 3.5%, respectively, while CWT loss was 18.4%.

7. The age composition of coho adults, measured from the recovery sample, was 98.3% age 3_2 and 1.7% age 4_3. Adult POH length averaged 44.2 cm for males and 46.8 cm for females.

8. Biases were identified in both the application and recovery samples. None of the biases were likely to have influenced the accuracy of the escapement estimate.

ACKNOWLEDGEMENTS

Field work was conducted by D. Cloustons, R. Fitzpatrick and C. McNair under the supervision of M. Milko.

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APPENDICES

Appendix 1a. Daily fence trap catches in the Salmon River, 1989.

Date	Water temp. (C) a	Water level (m) a	Coho smolt	Cutthroat Smolt	Cutthroat Parr	Rainbow Smolt	Rainbow Parr	Lamprey	Sculpin	Stickle-back	Cray-fish	Sucker
21-Apr	-	1.40	78	11	1	8	-	0	0	0	0	0
22-Apr	10.0	1.20	108	10	5	10	-	0	1	0	0	0
23-Apr	9.5	1.14	159	24	2	29	-	1	5	0	0	0
24-Apr	9.5	1.05	252	17	3	5	-	0	1	0	0	0
25-Apr	9.5	0.98	183	14	1	2	-	0	2	0	0	1
26-Apr	11.0	0.95	974	17	1	7	-	2	1	0	3	0
27-Apr	11.0	0.96	1304	61	4	23	-	7	1	0	0	2
28-Apr	10.5	0.93	1373	21	7	11	-	4	1	0	0	0
29-Apr	12.0	0.93	1357	16	2	23	-	5	0	0	0	0
30-Apr	12.0	0.88	1070	2	1	20	-	7	3	0	0	0
01-May	11.5	0.88	508	25	0	10	-	3	0	0	0	0
02-May	12.0	0.88	2111	291	4	119	-	7	0	0	0	0
03-May	12.5	0.85	1041	106	2	26	-	0	1	0	0	0
04-May	11.0	0.88	1603	102	3	25	-	5	3	0	0	0
05-May	12.0	0.84	954	130	3	20	-	2	4	0	1	0
06-May	13.0	0.82	808	109	1	19	-	0	0	0	0	0
07-May	14.0	0.83	1636	94	4	63	-	4	1	0	1	0
08-May	12.0	0.82	1916	8	0	1	-	0	0	0	0	0
09-May	12.0	0.80	1202	86	3	62	-	5	0	0	0	0
10-May	11.0	0.79	864	89	4	38	-	0	0	0	0	0
11-May	10.0	0.83	536	103	3	33	-	0	0	0	0	0
12-May	9.0	0.83	275	110	5	25	-	0	1	0	1	0
13-May	9.0	0.81	651	76	11	15	-	1	0	0	0	0
14-May	11.5	0.80	581	97	2	15	-	0	3	0	1	0
15-May	10.5	0.79	458	65	6	8	-	0	1	0	1	0
16-May	12.0	0.85	877	30	3	28	-	1	1	0	0	0
17-May	10.5	0.8	331	55	4	16	-	0	1	0	2	0
18-May	9.5	1.14	649	263	22	52	-	0	0	0	0	0
19-May	10.0	1.09	504	130	10	36	-	1	0	0	0	0
20-May	9.0	0.98	439	135	13	16	-	0	0	0	0	0
21-May	11.0	0.9	125	32	3	16	-	0	4	0	1	0
22-May	10.0	0.96	64	11	4	0	-	0	2	0	0	0
23-May	10.0	0.88	21	26	2	2	-	0	0	0	1	0
24-May	10.0	1.25	206	210	12	57	-	0	0	0	0	0
25-May	10.0	1.25	307	55	7	24	-	1	1	0	0	0
26-May	10.0	1.09	124	41	2	31	-	0	0	0	0	0
27-May b	10.5	2.49	-	-	-	-	-	-	-	-	-	-
Total	-	-	25,649	2,672	160	895	-	56	38	0	12	3

a. Recorded at approximately 0800 hrs.
b. Trap out due to high water.

Appendix 1b. Daily fence trap catches in Coghlan Creek, 1989.

Date	Water temp. (C) a	Water level (m) a	Coho smolt	Cutthroat Smolt	Cutthroat Parr	Rainbow Smolt	Rainbow Parr	Lamprey	Sculpin	Stickleback	Crayfish	Sucker
19-Apr	-	1.00	89	6	14	12	-	0	0	0	0	0
20-Apr	-	1.00	248	12	15	9	-	0	0	0	0	0
21-Apr	-	1.19	303	145	22	58	-	0	0	0	0	0
22-Apr	9.5	1.07	131	6	2	0	-	0	1	0	0	0
23-Apr	9.0	1.05	200	15	4	0	-	1	1	0	0	0
24-Apr	9.0	1.00	254	15	6	6	-	0	0	0	0	0
25-Apr	9.0	0.99	508	33	6	5	-	1	0	0	2	0
26-Apr	10.0	0.98	608	63	10	7	-	2	0	0	4	0
27-Apr	10.5	0.98	1012	79	19	16	-	3	0	0	0	0
28-Apr	10.0	1.00	1011	39	3	6	-	0	0	0	1	0
29-Apr	12.0	0.98	314	18	5	5	-	0	0	0	0	0
30-Apr	11.0	0.98	644	58	3	25	-	0	0	0	0	0
01-May	11.0	1.00	621	61	8	11	-	3	2	0	1	0
02-May	11.0	0.98	377	64	8	6	-	2	0	0	0	0
03-May	12.0	1.00	721	82	2	7	-	1	1	0	0	0
04-May	10.5	0.96	386	78	1	4	-	0	0	0	0	0
05-May	11.0	0.97	827	81	5	12	-	5	2	0	1	1
06-May	12.0	0.98	479	17	8	4	-	0	0	0	0	0
07-May	13.0	0.96	556	116	2	15	-	0	1	0	4	0
08-May	11.0	1.00	784	2	0	0		0	0	0	0	0
09-May	10.5	0.94	243	42	1	8	-	0	0	0	1	0
10-May	10.0	0.96	343	45	0	6	-	0	0	0	1	0
11-May	9.0	0.98	300	52	1	1	-	0	0	0	0	0
12-May	8.5	0.95	283	49	2	8	-	0	0	0	2	0
13-May	9.0	0.95	180	45	1	3	-	0	0	0	1	0
14-May	11.0	0.95	192	101	4	2	-	0	1	0	0	0
15-May	10.0	0.94	270	51	1	1	-	0	0	0	1	0
16-May	11.0	0.80	314	83	9	2	-	0	0	0	0	0
17-May	10	0.91	158	5	1	1	-	0	0	0	0	0
18-May	9	1.14	526	168	7	17	-	0	2	0	0	0
19-May	9.5	1.05	23	4	0	0	-	0	0	0	0	0
20-May	9	0.95	199	66	6	4	-	0	0	0	0	0
21-May	10	0.98	134	64	3	3	-	0	1	0	1	0
22-May	9.5	0.86	78	20	2	1	-	0	0	0	0	0
23-May	9.5	1	39	17	1	0	-	0	0	0	0	0
24-May	9.5	1.43	211	43	9	17	-	0	1	0	0	0
25-May	9	1.2	2	1	0	0	-	0	0	0	0	0
26-May	10	1.02	0	0	0	0	-	0	0	0	0	0
27-May b	10	2.03	-	-	-	-	-	-	-	-	-	-
Total	-	-	13,568	1,846	191	282	-	18	13	0	20	1

a. Recorded at approximately 0800 hrs.
b. Trap out due to high water.

Appendix 2a. Salmon River coded wire tagging results (codes 02 57 25 and 02 63 22), 1989.

CWT code	Tagging date	Maximum holding time (days)	Pre-tagging mortality	Total number marked	24 hour CWT rejection		Post tagging mortality		Total released with CWTs c
					N a	(%)	Immediate	24-hour b	
02 57 25	21-Apr	1	0	78	-	-	0	0	64
	25-Apr	1	0	182	234	5.5	0	0	149
	26-Apr	1	0	972	-	-	6	0	788
	27-Apr	1	0	1,314	186	14.5	7	0	1,066
	28-Apr	1	19	1,365	156	1.3	28	0	1,091
	29-Apr	1	0	19	-	-	0	2	14
	01-May	2	2	2,852	256	6.6	0	0	2,327
	02-May	1	0	2,109	311	8.4	0	0	1,721
	03-May	1	0	1,062	-	-	1	0	866
	Total (Mean)		21	9,953	1,143	(7.5)	42	2	8,085
02 63 22	04-May	1	48	1,555	220	4.0	32	0	1,243
	05-May	1	3	961	-	-	1	0	783
	08-May	3	1	2,403	-	-	0	0	1,961
	09-May	1	3	3,105	275	1.9	7	0	2,529
	10-May	1	0	863	262	0.5	0	0	704
	11-May	1	0	536	260	0.8	0	0	437
	12-May	1	0	271	-	-	4	0	218
	15-May	3	0	1,688	344	0.1	0	0	1,377
	Total (Mean)		53	11,382	1,361	(1.7)	44	0	9,251
Total (Mean)		(1.3)	74	21,335	2,504	(4.6)	86	2	17,337

a. Sample size held to assess tag loss.
b. Based on mortality rate observed in QCD subsample expanded to entire tag lot.
c. Adjusted for long term CWT loss (see text).

Appendix 2b. Coghlan Creek coded wire tagging results (codes 02 57 25 and 02 63 22), 1989.

CWT code	Tagging date	Maximum holding time (days)	Pre-tagging mort-ality	Total number marked	24 hour CWT rejection		Post tagging mortality		Total released with CWTs c
					N a	(%)	Immediate	24-hour b	
02 57 25	21-Apr	3	3	622	176	3.5	11	0	499
	25-Apr	3	0	1,095	-	-	1	0	893
	26-Apr	1	1	496	291	9.6	0	0	405
	27-Apr	1	3	603	207	8.2	0	1	491
	28-Apr	1	0	1,009	208	29.3	2	0	822
	29-Apr	1	1	1,011	226	1.3	0	2	823
	01-May	2	0	620	-	-	0	0	506
	02-May	1	0	1,318	-	-	0	0	1,075
	03-May	1	0	717	298	1.0	0	0	585
	Total (Mean)		8	7,491	1,406	(9.8)	14	3	6,098
02 63 22	04-May	1	0	385	192	0.5	1	0	313
	05-May	1	1	821	253	5.5	2	0	668
	08-May	3	1	1,832	341	3.2	1	0	1,494
	09-May	1	0	252	-	-	0	0	206
	10-May	1	0	337	-	-	0	0	275
	11-May	1	0	300	-	-	0	0	245
	12-May	1	0	285	253	1.0	0	0	233
	15-May	3	0	54	-	-	2	0	42
	Total (Mean)		2	4,266	1,039	(3.3)	6	0	3,478
Total (Mean)		(1.5)	10	11,757	2,445	(7.0)	20	3	9,574

a. Sample size held to assess tag loss.
b. Based on mortality rate observed in QCD subsample expanded to entire tag lot.
c. Adjusted for long term CWT loss (see text).

Appendix 3. Incidence of anomalies encountered while coded wire tagging wild Salmon River system coho salmon smolts, 1989.

Location	Number inspected	Fog eye	Neascus	Fin rot	General damage	Missing adipose fin
Salmon River	21,335	2,708	1,694	0	3	1
	%	12.7%	7.9%	0.0%	0.014%	0.005%
Coghlan Creek	11,757	1,087	496	0	1	2
	%	9.2%	4.2%	0.0%	0.009%	0.017%
Total	33,092	3,795	2,190	0	4	3
	% total	11.5%	6.6%	0.0%	0.012%	0.009%

Appendix 4. Mean length and weight of coho salmon smolts in the Salmon River system, 1989.

Location	Sample date	Sample size	Nose-Fork length: Mean	Nose-Fork length: Standard deviation	Mean wet weight (g)
Salmon River	25-Apr	50	101.1	17.1	8.9
	28-Apr	50	95.4	13.3	9.3
	02-May	50	96.3	11.3	8.8
	05-May	50	96.2	11.2	9.9
	09-May	50	95.6	10.0	9.0
	12-May	50	93.1	9.9	8.5
	16-May	50	89.9	9.2	7.3
	19-May	50	90.4	5.7	7.1
	23-May	50	94.7	12.4	9.1
	26-May	50	105.6	17.3	12.7
	Total	500	95.2 a	-	8.9 a
Coghlan Creek	25-Apr	50	98.6	11.3	10.1
	28-Apr	50	97.5	9.6	9.5
	02-May	50	93.0	10.4	8.3
	05-May	50	91.1	5.9	8.0
	09-May	50	93.8	15.4	9.1
	12-May	50	92.6	6.5	8.6
	16-May	50	92.5	5.5	8.4
	19-May	23	92.0	5.3	8.4
	23-May	50	95.1	9.0	8.8
	Total	423	94.4 a	-	8.9 a
Total	-	923	94.9 a	-	8.9 a

a. Weighted by proportion of smolt migration in time periods.

Appendix 5a. Coho adult disk tag application results in the Salmon River, 1990-91. a

		Adipose present			Adipose absent			Total		
Date	Reach b	Male	Female	Total	Male	Female	Total	Male	Female	Total
31-Oct	S1	11	7	18	5	3	8	16	10	26
	S3	4	1	5	1	1	2	5	2	7
02-Nov	S1	9	4	13	3	0	3	12	4	16
	S2	2	3	5	3	6	9	5	9	14
	S3	2	1	3	3	1	4	5	2	7
	S4	0	1	1	0	0	0	0	1	1
05-Nov	S1	12	21	33	6	5	11	18	26	44
07-Nov	S2	1	3	4	1	1	2	2	4	6
	S3	3	1	4	0	0	0	3	1	4
	S4	1	1	2	1	0	1	2	1	3
14-Nov	S1	3	4	7	0	0	0	3	4	7
	S2	3	3	6	0	0	0	3	3	6
	S3	3	4	7	2	1	3	5	5	10
	S4	3	3	6	2	1	3	5	4	9
16-Nov	S3	2	4	6	1	0	1	3	4	7
	S4	8	4	12	3	6	9	11	10	21
19-Nov	S1	9	13	22	1	2	3	10	15	25
	S5	6	6	12	5	7	12	11	13	24
21-Nov	S3	1	2	3	0	1	1	1	3	4
	S4	2	6	8	0	4	4	2	10	12
28-Nov	S5	1	1	2	2	1	3	3	2	5
30-Nov	S3	1	0	1	1	1	2	2	1	3
	S4	2	1	3	0	0	0	2	1	3
Total	S1	44	49	93	15	10	25	59	59	118
	S2	6	9	15	4	7	11	10	16	26
	S3	16	13	29	8	5	13	24	18	42
	S4	16	16	32	6	11	17	22	27	49
	S5	7	7	14	7	8	15	14	15	29
	Total	89	94	183	40	41	81	129	135	264

a. Not corrected for sex identification error.

b. Salmon River reaches: S1 - below Coghlan Creek.
S2 - Coghlan Creek to 64 Ave.
S3 - 64 Ave. to 56 Ave.
S4 - 56 Ave. to 248 St.
S5 - 248 St. to 256 St.

Appendix 5b. Coho adult disk tag application results in Coghlan Creek, 1990-91. a

		Adipose present			Adipose absent			Total		
Date	Reach b	Male	Female	Total	Male	Female	Total	Male	Female	Total
31-Oct	C1	3	3	6	1	0	1	4	3	7
02-Nov	C2	4	4	8	0	1	1	4	5	9
05-Nov	C1	6	4	10	1	1	2	7	5	12
14-Nov	C1	6	5	11	1	1	2	7	6	13
16-Nov	C1	9	7	16	4	0	4	13	7	20
	C5	9	6	15	5	2	7	14	8	22
19-Nov	C3	10	8	18	4	2	6	14	10	24
	C4	9	6	15	6	2	8	15	8	23
21-Nov	C1	4	6	10	1	0	1	5	6	11
	C2	3	4	7	2	1	3	5	5	10
30-Nov	C3	1	1	2	0	0	0	1	1	2
	C4	4	3	7	1	1	2	5	4	9
	C5	0	2	2	0	2	2	0	4	4
Total	C1	28	25	53	8	2	10	36	27	63
	C2	7	8	15	2	2	4	9	10	19
	C3	11	9	20	4	2	6	15	11	26
	C4	13	9	22	7	3	10	20	12	32
	C5	9	8	17	5	4	9	14	12	26
	Total	68	59	127	26	13	39	94	72	166

a. Not corrected for sex identification error.

b. Coghlan Creek reaches:
C1 - Salmon River to Hwy. 1.
C2 - Hwy. 1 to 248 St.
C3 - 248 St. to 64 Ave.
C4 - 64 Ave. to 256 St.
C5 - Above 256 St.

Appendix 6. Disk tag recoveries in the Salmon River system, by application and recovery date and location, 1990-91.

Application sample					Recovery sample					
Date	Reach c	NF length (cm)	Sex	Adipose fin	Date	Reach	POH length (cm)	Sex		Time out (days)
31-Oct	S1	55.5	M	A	28-Nov	C1	42.5	M		28
31-Oct	S3	65.0	F	A	28-Nov	S3	45.7	F		28
02-Nov	S3	54.2	M	A	21-Dec	S4	41.6	M		49
02-Nov	S3	60.0	F	P	14-Dec	S3	50.2	F		42
02-Nov	S3	60.0	M	A	14-Dec	S3	48.8	M		42
02-Nov	C2	63.5	F	P	07-Dec	C2	-	F	b	35
02-Nov	C2	59.0	M	P	28-Nov	C1	46.1	M		26
05-Nov	S1	48.0	M	P	28-Nov	C1	38.1	M		23
05-Nov	S1	60.0	F	P	28-Nov	S1	47.0	F		23
05-Nov	C1	59.5	F	P	28-Nov	C2	-	F		23
05-Nov	C1	55.0	M	P	28-Nov	C1	43.4	M		23
07-Nov	S4	51.5	F	P	07-Dec	S3	40.0	M	a	30
07-Nov	S2	50.5	M	A	28-Nov	C1	39.0	M		21
14-Nov	C1	55.5	F	P	14-Dec	S1	46.0	F		30
14-Nov	C1	53.0	M	P	14-Dec	C1	41.8	M		30
14-Nov	S2	55.5	F	P	28-Nov	S1	46.0	F		14
14-Nov	S3	55.0	M	A	14-Dec	S3	45.2	M		30
16-Nov	S3	55.0	F	P	14-Dec	S3	45.6	F		28
16-Nov	S3	57.5	M	P	07-Dec	S3	46.0	F	a,b	21
16-Nov	S3	59.0	M	A	14-Dec	S3	49.3	M		28
16-Nov	S4	58.5	F	A	14-Dec	S3	-	F		28
16-Nov	S4	60.0	F	P	14-Dec	S4	49.0	F		28
16-Nov	S4	52.0	M	P	14-Dec	S3	42.1	F	a	28
16-Nov	S4	48.0	F	P	27-Dec	S4	39.7	F		41
16-Nov	C1	57.0	M	P	28-Nov	C1	45.2	M		12
16-Nov	C1	46.0	M	P	14-Dec	S1	37.0	M		28
16-Nov	C1	59.5	F	P	28-Nov	S1	-	F		12
16-Nov	C1	49.0	M	P	07-Dec	C1	39.7	M		21
16-Nov	C1	48.5	M	A	28-Nov	C2	42.1	M		12
16-Nov	C1	56.0	M	P	28-Nov	S1	45.5	M		12
16-Nov	C5	63.0	F	P	26-Nov	C4	50.0	F		10
16-Nov	C5	69.0	M	A	26-Nov	C4	53.7	M		10
16-Nov	C5	60.5	M	P	26-Nov	C4	48.0	M		10
16-Nov	C5	53.5	M	P	14-Dec	C3	41.5	M		28
16-Nov	C5	66.0	F	P	07-Dec	C4	53.9	F		21
16-Nov	C5	47.0	M	P	07-Dec	C5	37.0	M		21
16-Nov	C5	60.0	M	A	26-Nov	C4	48.0	M		10
16-Nov	C5	70.0	M	A	26-Nov	C4	57.0	M		10
16-Nov	C5	58.0	M	P	26-Nov	C5	39.7	M		10
19-Nov	C3	60.0	M	A	28-Nov	C2	46.2	M		9
19-Nov	C3	58.0	F	P	28-Nov	C2	46.4	F		9
19-Nov	C3	59.0	F	A	24-Dec	C3	48.5	F		35
19-Nov	C3	65.0	M	P	07-Dec	C2	50.6	M		18
19-Nov	C3	59.5	M	P	28-Nov	C2	44.3	M		9
19-Nov	C3	57.0	M	P	07-Dec	C1	44.5	M		18
19-Nov	C4	54.5	M	A	14-Dec	C3	42.4	M		25
19-Nov	C4	61.0	M	P	14-Dec	C3	47.1	M		25

Appendix 6. Disk tag recoveries in the Salmon River system, by application and recovery date and location, 1990-91.

Application sample					Recovery sample				
Date	Reach c	NF length (cm)	Sex	Adipose fin	Date	Reach	POH length (cm)	Sex	Time out (days)
19-Nov	C4	57.5	F	A	07-Dec	C5	49.0	F	18
19-Nov	C4	54.0	F	P	07-Dec	C2	43.6	F	18
19-Nov	C4	51.0	M	P	07-Dec	C3	38.7	M	18
19-Nov	C4	52.5	M	A	28-Nov	C2	40.9	M	9
19-Nov	C4	56.5	M	P	26-Nov	C3	43.8	M	7
19-Nov	C3	58.5	F	A	07-Dec	C3	46.2	F	18
19-Nov	S5	49.0	M	A	26-Nov	C3	38.0	M	7
19-Nov	S5	59.0	M	P	12-Dec	S4	47.8	M	23
19-Nov	S5	55.5	F	P	07-Dec	S3	44.0	F	18
19-Nov	S1	50.0	F	P	14-Dec	C3	41.6	F	25
19-Nov	S1	53.5	F	P	07-Dec	C1	41.8	F	18
19-Nov	S1	58.0	M	P	07-Dec	C1	43.7	M	18
21-Nov	C2	58.0	F	A	28-Nov	C2	49.3	F	7
21-Nov	C2	56.0	M	P	28-Nov	C1	44.7	M	7
21-Nov	C2	64.0	M	P	07-Dec	C3	-	M	16
21-Nov	C2	48.0	M	A	28-Nov	C1	38.0	M	7
21-Nov	C2	62.0	F	P	07-Dec	C2	49.7	F	16
21-Nov	C1	61.5	M	P	07-Dec	C1	48.8	M	16
21-Nov	C1	60.0	M	P	14-Dec	S1	47.0	M	23
21-Nov	C1	51.0	M	A	28-Nov	C1	40.6	M	7
28-Nov	S5	59.5	F	A	27-Dec	S4	47.6	F	29
28-Nov	S5	56.0	M	P	14-Dec	S4	45.0	M	16
30-Nov	C5	65.0	F	P	12-Dec	C4	52.5	F	12
30-Nov	C5	60.0	F	A	12-Dec	C4	48.5	F	12
30-Nov	C4	65.0	F	P	12-Dec	C4	52.2	F	12
30-Nov	C4	51.0	F	P	07-Dec	C2	39.4	F	7
30-Nov	S3	60.0	M	P	07-Dec	S3	46.5	M	7
30-Nov	S4	53.0	F	P	14-Dec	S3	42.5	F	14

Summary:

Females initially identified as males:	2	6.3%	Mean days out =	19.7
Males initially identified as females:	1	2.4%	Maximum days out =	49.0
			Minimum days out =	7.0

POH and NF regressions:

- Adult males: POH length = 0.76 NF length + 1.14
  NF length = 1.16 POH length + 5.01
- Adult females: POH length = 0.75 NF length + 3.92
  NF length = 1.13 POH length + 5.17

a. Incorrect sex identification during disk tag application
b. No secondary mark on recovery
c. Salmon River: S1 - below Coghlan Cr; S2 - Coghlan Cr. to 64 Ave; S3 - 64 Ave to 56 Ave; S4 - 56 Ave to 248 St; S5 - 248 St to 256 St. Coghlan Creek: C1 - Salmon R. to Hwy 1; C2 - Hwy 1 to 248 St; C3 - 248 St to 64 Ave; C4 - 64 Ave to 256 St; C5 - above 256 St.

Appendix 7a. Summary of live observations and dead counts of coho salmon in the Salmon River, 1990-91.

			Dead count											
			Adipose fin present				Adipose fin absent							
Date	Reach	Live count	Male	Female	Jack	Adult total	Male	Female	Jack	Adult total	Adult total	Disk tag and secondary mark	Secondary mark only	Disk tag only
20-Nov	S1	8	6	8	1	14	3	1	0	4	18	0	0	0
	S4	18	1	2	0	3	4	2	0	6	9	0	0	0
26-Nov	S4	61	18	22	4	40	6	7	0	13	53	0	0	0
	S5	28	1	0	1	1	1	0	0	1	2	0	0	0
28-Nov	S1	23	21	31	1	52	3	1	0	4	56	3	0	1
	S2	1	1	1	0	2	0	0	0	0	2	0	0	0
	S3	21	4	4	0	8	0	2	0	2	10	1	0	0
07-Dec	S3	15	17	18	0	35	5	3	0	8	43	4	0	0
	S4	11	9	9	0	18	2	1	0	3	21	0	0	0
12-Dec	S4	10	5	6	0	11	0	2	0	2	13	1	0	0
	S5	6	3	5	0	8	1	7	0	8	16	0	0	0
14-Dec	S1	-	10	23	0	33	3	5	0	8	41	3	1	0
	S2	3	2	3	0	5	0	0	0	0	5	0	0	0
	S3	6	14	22	1	36	4	4	0	8	44	7	0	0
	S4	-	9	14	3	23	5	2	0	7	30	2	0	0
21-Dec	S1	1	3	1	0	4	0	0	0	0	4	0	0	0
	S3	3	0	1	0	1	0	0	0	0	1	0	0	0
	S4	-	4	4	0	8	1	0	0	1	9	1	0	0
27-Dec	S4	3	2	5	0	7	2	7	0	9	16	2	0	0
	S5	-	2	1	0	3	0	0	0	0	3	0	0	0
03-Jan	S1	-	1	2	0	3	0	1	0	1	4	0	0	0
	S2	-	0	1	0	1	0	0	0	0	1	0	0	0
	S3	2	4	6	0	10		1	0	2	12	0	0	0
	S5	1	0	2	0	2		0	0	0	2	0	0	0
Total	S1	-	41	65	2	106	9	8	0	17	123	6	1	1
	S2	-	3	5	0	8	0	0	0	0	8	0	0	0
	S3	-	39	51	1	90	10	10	0	20	110	12	0	0
	S4	-	48	62	7	110	20	21	0	41	151	6	0	0
	S5	-	6	8	1	14	2	7	0	9	23	0	0	0
	Total	-	137	191	11	328	41	46	0	87	415	24	1	1

Appendix 7b. Summary of live observations and dead counts of coho salmon in Coghlan Creek, 1990-91.

			Dead count											
			Adipose fin present				Adipose fin absent					Disk tag and secondary mark	Secondary mark only	Disk tag only
Date	Reach	Live count	Male	Female	Jack	Adult total	Male	Female	Jack	Adult total	Adult total			
26-Nov	C3	12	3	1	0	4	1	0	0	1	5	2	0	0
	C4	40	14	12	1	26	12	5	0	17	43	5	0	0
	C5	23	1	1	0	2	1	0	0	1	3	1	0	0
28-Nov	C1	42	36	49	2	85	6	2	0	8	93	10	0	0
	C2	28	11	16	1	27	7	4	1	11	38	6	0	0
07-Dec	C1	51	23	23	0	46	2	3	0	5	51	5	0	0
	C2	16	11	14	0	25	2	0	0	2	27	5	0	0
	C3	21	13	17	0	30	4	2	0	6	36	3	0	0
	C4	24	5	10	0	15	1	2	0	3	18	1	0	0
	C5	-	4	1	0	5	0	3	0	3	8	2	0	0
12-Dec	C4	-	5	11	0	16	3	6	0	9	25	2	0	0
	C5	-	0	1	0	1	0	1	0	1	2	0	0	0
14-Dec	C1	-	7	4	0	11	1	0	0	1	12	1	0	0
	C2	9	3	2	0	5	0	0	0	0	5	0	0	0
	C3	-	19	22	0	41	2	3	0	5	46	4	0	1
24-Dec	C3	1	0	0	0	0	0	2	0	2	2	1	0	0
03-Jan	C1	-	6	8	0	14	0	0	0	0	14	0	0	0
	C2	-	1	1	0	2	0	0	0	0	2	0	0	0
	C3	2	1	4	0	5	0	2	0	2	7	0	0	0
	C4	-	1	1	0	2	0	0	0	0	2	0	0	0
	C5	3	2	4	0	6	1	3	0	4	10	0	0	0
Total	C1	-	72	84	2	156	9	5	0	14	170	16	0	0
	C2	-	26	33	1	59	9	4	1	13	72	11	0	0
	C3	-	36	44	0	80	7	9	0	16	96	10	0	1
	C4	-	25	34	1	59	16	13	0	29	88	8	0	0
	C5	-	7	7	0	14	2	7	0	9	23	3	0	0
	Total	-	166	202	4	368	43	38	1	81	449	48	0	1

Appendix 8. Spawning success of female coho adult spawning ground recoveries, 1990-91.

		Percent spawned			
		0%	50%	100%	Weighted mean
Disk tag or secondary mark	Number	1	0	30	31
	Percent	3.2%	0.0%	96.8%	96.8%
Unmarked	Number	1	1	88	90
	Percent	1.1%	1.1%	97.8%	98.3%
Total	Number	2	1	118	121
	Percent	1.7%	0.8%	97.5%	97.9%

Appendix 9. Observed and estimated coho adult escapement, by CWT code, in the Salmon River, system, 1990-91.

		CWT Code		No CWT		
	Total	02 57 25	02 63 22	Jack	Adult	CWT Lost
Estimated AFC escapement	970	-	-	-	-	-
No. AFCs recovered	168	-	-	-	-	-
Observed CWT codes	133	58	77	-	30	-
Estimated escapement by code	-	333	458	-	179	-

a. Adults only.
b. Excludes 5 recovered without heads.

Appendix 10. Incidence of CWT loss by carcass condition, eye status and AFC condition in AFC coho adult carcasses in the Salmon River system, 1990-91.

Group	Sample size a	CWT absent	CWT loss (%)
Condition 1	17	1	5.8%
Condition 2	81	13	16.0%
Condition 3	59	14	24.1%
Condition 4	6	2	28.6%
Eyes present	134	25	18.7%
Eyes absent	29	5	17.2%
Complete AFC	136	21	15.3%
Partial AFC	22	7	30.4%
Questionable AFC	2	1	50.0%

a. Excludes 5 recovered without heads

Appendix 11. Mean length, by sex and age, of Salmon River system coho spawners, 1990-91.

Sample	Age	Sex	Sample size	Percent	Length (cm.) Mean	Standard deviation	Range
Application sample a, b	-	Male	221	51.8%	54.1	6.4	35.5 - 78.0
	-	Female	206	48.2%	56.9	4.9	38.5 - 69.0
Recovery sample c	4/3	Male	1	0.9%	42.1	-	- - - -
		Female	1	0.9%	45.3	-	- - - -
	3/2	Male	53	46.1%	45.1	3.3	36.1 - 57.0
		Female	58	50.4%	46.9	4.0	36.8 - 57.5
	2/2	Male	2	1.7%	22.4	4.3	18.1 - 26.8
	Total	Male	56	48.7%	44.2	6.7	18.1 - 57.0
		Female	59	51.3%	46.8	3.9	36.8 - 57.5

a. Not adjusted for sex identification errors.
b. MF length.
c. POH length.